RECENT PROGRESS ON COMPUTATIONAL INVERSE TECHNIQUES FOR CRACK DETECTION USING ELASTIC WAVES

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Computational inverse techniques have become a very important tool in practical engineering applications related to non-destructive evaluation (NDE) and non-destructive testing (NDT). Elastic waves are often preferred for many engineering applications due to their natural advantages on safety, and the applicability to almost all kinds of solid materials. With the aid of computer power, and the advances in numerical solvers for elastic waves [1], the use of elastic waves is becoming one of the most powerful and feasible tool in NDE or NDT, because it allows the use of dispersive waves of larger wavelength to achieve deeper penetration.

This paper presents several computational inverse techniques for crack detection using elastic waves propagating in composite structures. In these techniques, the inverse problems are formulated into parameter identification problems in which a set of parameters corresponding to the characteristics of crack, can be found by minimizing error functions formulated using the measured displacement responses and that computed using forward solvers based on projected values of parameters. The forward solver used in this work is the strip element method (SEM) [1]. The SEM has been proven very effective for wave scattering analysis in cracked structures. The high efficiency of this forward solver paves the way for the inverse procedure to solve the inverse problems using elastic waves. A recently developed simple regularization method [2] can be used for stabilizing effectively computational solutions of the ill-posed inverse problems. Exact characteristic parameters were detected by incorporating genetic algorithm with the forward numerical procedure of SEM. Uniform micro-genetic algorithm (GA) [3], intergeneration project GA (IP-GA) [4], improved IP-GA [5] as well the combination of GA and nonlinear LSM [6] play a key role in the detection procedure. The crack detection problem in laminated plate is also solved as an identification problem using the progressive neural network [7]. The excited displacement response on the surface of plate is used as the input of the NN model. The crack parameters are used as the output of the NN model. These computational inverse techniques are applied for several actual engineering problems.

References

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